CLAIMS:

1. An electrochemical cell for electrochemical reduction of a metal oxide, such as titania, in a solid state, which electrolytic cell includes (a) a molten electrolyte, (b) a cathode formed at least in part from the metal oxide in contact with the electrolyte, (c) an anode, and (d) a membrane that separates the electrolyte and the anode and is permeable to oxygen cations and is impermeable to dissolved metal in the electrolyte, and optionally is impermeable to any one or more of (i) electrolyte anions other that oxygen anions, (ii) anode metal cations, and (iii) any other ions and atoms.

2. The cell defined in claim 1 wherein the anode is a molten metal anode.

3. The cell defined in claim 1 or claim 2 wherein the anode includes a means for scavenging oxygen that is generated at the anode, in use of the cell, when oxygen anions migrate to the anode and give up electrons at the anode.

4. The cell defined in claim 2 wherein the metal of the molten metal anode has a melting point that is within the operating temperature range of the electrolyte.

5. The cell defined in claim 4 wherein the melting point of the metal of the molten metal anode is higher than the melting point of the electrolyte and lower than the vaporisation and/or decomposition temperature of the electrolyte in order to prevent electrolyte consumption and removal through vaporisation.

6. The cell defined in any one of claims 2 to 5 wherein the metal of the molten metal anode is silver or copper.

7. The cell defined in any one of the preceding claims wherein the membrane is impermeable to the anode electrode material.

8. The cell defined in any one of the preceding claims wherein the membrane is formed from a solid electrolyte.

9. The cell defined in claim 8 wherein the solid electrolyte is an oxide.

10. The cell defined in claim 8 wherein the solid electrolyte is yttria stabilised zirconia.

11. The cell defined in any one of the preceding claims wherein the membrane includes a body and an outer lining, with the outer lining being in contact with the electrolyte, and the outer lining being formed from a material that is inert with respect to dissolved metal in the electrolyte and is impermeable to the dissolved metal.

12. The cell defined in claim 11 wherein the body is formed from the solid electrolyte.

13. The cell defined in claim 11 or claim 12 wherein the outer lining is formed from a rare earth oxide.

14. The cell defined in claim 13 wherein the rare earth oxide is yttria.

15. The cell defined in any one of claims 11 to 14 wherein the lining is continuous and covers all of the surface of the membrane that is in contact with the electrolyte so that there are no sections of the body that are in contact with the electrolyte.

16. The cell defined in any one of the preceding claims wherein the metal oxide is a titanium oxide.

17. The cell defined in any one of the preceding claims wherein the metal oxide is titania.

18. The cell defined in any one of the preceding claims wherein, in a situation in which the metal oxide is titania, the electrolyte is a $CaCl_2$-based electrolyte that includes CaO as one of the constituents.

19. A method of electrochemically reducing a metal oxide in a solid state in an electrochemical cell, which electrochemical cell includes (a) a molten electrolyte, (b) a cathode in contact with the electrolyte, the cathode being formed at least in part from the metal oxide, (c) an anode, and (d) a membrane that separates the electrolyte and the anode and is permeable to oxygen ions and is impermeable to dissolved metal in the electrolyte, and optionally is impermeable to any one or more of (i) electrolyte anions other that oxygen anions, (ii) anode metal cations, and (iii) any other ions and atoms, and which method includes applying a cell potential across the anode and the cathode and electrochemically reducing the metal oxide.

20. The method defined in claim 19 includes operating the cell with a molten metal anode.

21. The method defined in claim 19 or claim 20 includes maintaining the cell temperature below the vaporisation and/or decomposition temperatures of the electrolyte.

22. The method defined in any one of claims 19 to 21 includes applying a cell potential above a decomposition potential of at least one constituent of the electrolyte so that there are cations of a metal other than that of the cathode metal oxide in the electrolyte.

23. The method defined in any one of claims 19 to 22 includes scavenging oxygen that is generated at the anode when oxygen anions migrate to the anode and give up electrons at the anode.

24. The method defined in any one of claims 19 to 22 wherein, in a situation in which the metal oxide is titania, the method includes electrochemically reducing the metal oxide to titanium having an oxygen concentration of less than 0.2wt.%.